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CONTAINMENT REPORT FOR METROPOLITAN EDISON

DRL:C&CTB:NHD RT-288 50-289

Attached is a report on the containment vessel proposed for Metropolitan Edison Company's Three Mile Island Unit I.

This report is based on N. H. Davison's review of the submitted PSARs and Amendments 1 through 4, telephone conversations with Don Croneburger of Gilbert Associates, and his attendance at portions of the applicants presentations to the staff.

Attachment:
Report

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METROPOLITAN EDISON CONTAINMENT REPORT

(Docket No. 50-289)

Description

The containment structure proposed for Metropolitan Edison Company's Three Mile Island Nuclear Station, Unit 1, is a structural concrete containment prestressed across the dome and throughout the side walls and employs a steel reinforced concrete for the base slab. Most structural details are basically the same as the previously reviewed concrete containment designs.

The reactor containment structure, which encloses the primary system, steam generators, and related auxiliaries, consists of a concrete shell in the form of a vertical right circular cylinder with a shallow ellipsoidal dome and a flat slab base. A welded mild steel (A-36) liner of three-eighths inch thickness for the cylinder and dome and one-fourth inch thickness for the base slab is attached to the inside surface of the concrete shell as a provision to ensure leaktightness.

The base slab is of reinforced concrete construction using a high strength grade steel.

The cylinder walls are prestressed circumferentially against hoop stress by three staggered systems of prestressing tendons anchored at six vertical buttresses. The cylinder walls are also prestressed vertically with a series of uniformly spaced tendons extending from the top of the ring girder (thickened section at cylinder and dome intersection) to the bottom of the base slab. Local base moment is carried by reinforcing bars placed in a diagonal pattern in the slab and extending up inside the cylindrical wall about twelve feet.

The dome is prestressed by a three way tendon system extending across the dome and anchored on a horizontal plane on the dome ring girder.

A grid of supplemental reinforcement consisting of reinforcing bars is provided on the exterior face of the cylinder and dome for crack control.

Additional reinforcement is provided on the interior face at the dome line and in the anchorage zones. Rigid shear "T" and "L" connectors are provided on the liner exterior face.

The prestressing tendon pattern is deflected around the major cylinder penetrations (personnel and equipment access hatches) and additional steel reinforcement is provided for local moment and shear.

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Loadings

The major loadings considered by the applicant include dead load, accident pressure, accident temperature, seismic, and wind. The applicant also considers external pressure, tornado, and missile loadings. The loadings and their manner of combination are the same as previously reviewed for concrete containments. The factored load equations combines realistically all significant loads and are acceptable.

Structural Analysis Details

The static load stresses and deflections for the shells of revolution are calculated by an exact numerical solution of the general bending theory of shells. This analysis employs the differential equations derived by E. Reissner. These equations are based on the linear theory of elasticity, and they take into account the bending as well as the membrane action of the shell. The method of solution is the multisegment method of direct integration, which is capable of calculating the exact solution of an arbitrary thin, elastic shell of revolution when subjected to any given edge, surface, and temperature loads.

The stresses and displacements of the response of the shells of revolution to the excitation of an earthquake is calculated by superimposing the normal modes of free-vibration of the shell. The translatory inertia terms in the normal, meridional, and circumferential direction of the shell are taken into account. The mass distribution is the actual mass distribution of the shell and no approximations are made.

The equipment access hatch is approximately twenty-two feet in diameter and the personnel hatch is nine and one-half feet in diameter. This represents a considerable increase in typical overall hatch size for these types of containments and, to an extent, increases the designer's problems with regard to tendon deflection around the opening and proper reinforcement for local stresses. The Franklin Institute has been engaged to make a computerized finite element analysis of the design. Since such an analysis technique enables the analyst to account for the variation in structural stiffness and predict detailed stress patterns around the large openings in a precise manner, the analysis of the opening design through use of this technique should provide added assurance of its adequacy. Based on the results of this design analysis, a meaningful confirmatory instrumentation program for the opening will be developed. This combination of analysis and thorough instrumentation during the proof test provides assurance that the functional performance objectives for the large openings will be achieved.

Construction

The materials of construction, i.e., the prestressing system, tendon

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